CLAIMS

What is claimed is:

1. A data processing pipeline comprising:

a first circuit, the first circuit classifying a data set received based on at least a criterion, based on a classification, the first circuit selecting a process mode to process the data set to minimize power consumption without sacrificing quality and performance; and

a second circuit coupled to the first circuit coupled to the first circuit, the second circuit processing data received from the first circuit.

2. The data processing pipeline of claim 1, wherein the second circuit comprising:

a first data processing circuit, the first data processing circuit processing data having a first classification in a low precision processing mode; and

a second data processing circuit, the second data processing circuit processing data having a second classification in a high precision processing mode.

3. The data processing pipeline of claim 2, wherein the second circuit further comprising:

a third data processing circuit coupled to the first data processing circuit, the third data processing circuit processing data having a first classification received from the first data processing circuit; and

a fourth data processing circuit coupled to the second data processing circuit, the fourth data processing circuit processing data having a second classification received from the second data processing circuit.

4. The data processing pipeline of claim 2, wherein the second circuit further comprising a third data processing circuit coupled to the first data processing

circuit and the second data processing circuit, the third data processing circuit performing data processing on all data regardless of classification.

5. The data processing pipeline of claim 1, wherein the second circuit comprising a configurable data processing circuit, the configurable data processing circuit is configured based on a first classification to process data in a low precision processing mode, the configurable data processing circuit is configured based on a second classification to process data in a high precision processing mode.

6. The data processing pipeline of claim 5, wherein the second circuit further comprising a third data processing circuit coupled to the configurable data processing circuit, the third data processing circuit performing data processing on all data regardless of classification.

7. The data processing pipeline of claim 6 further comprising a user interface coupled to the first circuit, the user interface communicating input information by a user to the first circuit to configure the configurable data processing circuit to operate in a desired precision operating mode.

8. The data processing pipeline of claim 7, wherein the desired precision mode selected by the user overrides the precision mode selected by the first circuit.

9. The data processing pipeline of claim 6 further comprising a power monitor coupled to the first circuit, the power monitor determining a power level needed to ensure continuing operation of a portable hand-held device until a conclusion of an actively running application and selecting

an appropriate precision operating mode, the power monitor communicating the determined precision operating mode to the first circuit to configure the configurable data processing circuit to operate in the selected precision operating mode.

10. The data processing pipeline of claim 9, wherein the selected precision mode overrides the precision mode selected by the first circuit.

11. The data processing pipeline of claim 4 further comprising a user interface coupled to the first circuit, the user interface communicating input information by a user to the first circuit to configure the configurable data processing circuit to operate in a desired precision operating mode.

12. The data processing pipeline of claim 11, wherein the desired precision mode selected by the user overrides the precision mode selected by the first circuit.

13. The data processing pipeline of claim 4 further comprising a power monitor coupled to the first circuit, the power monitor determining a power level needed to ensure continuing operation of a portable hand-held device until a conclusion of an actively running application and selecting an appropriate precision operating mode, the power monitor communicating the determined precision operating mode to the first circuit to configure the configurable data processing circuit to operate in the selected precision operating mode.

14. The data processing pipeline of claim 13, wherein the power monitor makes the determination by comparing an indicator of available power with an indicator of remaining operating time of the actively running application.

15. A graphics engine coupled to memory and a Central Processing Unit (CPU) comprising:

a primitive setup engine receiving data related to graphics primitives from memory, the primitive setup engine comprising a primitive classification circuit, the primitive classification circuit classifying a primitive, based on a classification, the primitive setup engine selecting a processing mode to compute setup equations for the primitive to minimize power consumption without sacrificing quality and performance; and

a rendering/rasterization engine coupled to the triangle setup engine, the rendering/rasterization engine performing primitive pixel rasterization.

16. The graphics engine of claim 15, wherein the primitive is classified based on its size and other characteristics.

17. The graphic engine of claim 16, wherein the primitive is classified as either small and well-behaved, large, or misbehaved.

18. The graphic engine of claim 16, wherein classification criteria for the other characteristics include texture, width, and depth.

19. The graphic engine of claim 17, wherein the primitive setup engine further comprising:

a first iterator setup calculation circuit coupled to the primitive classification circuit, the first iterator setup calculation circuit computing the setup equations for a primitive classified as small and well-behaved in a low precision processing mode as directed by the primitive classification circuit; and

a second pixel iterator setup calculation circuit coupled to the primitive classification circuit, the second

iterator setup calculation circuit computing the setup equations for a primitive classified as large or misbehaved in a high precision processing mode as directed by the primitive classification circuit.

20. The graphics engine of claim 19, wherein the low precision processing mode involves 16 mantissa bits for floating-point calculation and the high precision processing mode involves 24 mantissa bits for floating-point calculation.

21. The graphics engine of claim 19, wherein the rendering/rasterization engine comprising:

a first pixel iterator circuit performing scan line rasterization on primitives classified as small and well-behaved;

a first perspective divide circuit connected to the first pixel iterator circuit which is connected to the first iterator setup calculation circuit thereby forming a low precision pipeline, the first perspective divide circuit performing perspective correction on texture attributes of primitives classified as small and well-behaved;

a second pixel iterator circuit performing scan line rasterization on primitives classified as large or misbehaved; and

a second perspective divide circuit connected to the second iterator circuit which is connected to the second iterator setup calculation circuit thereby forming a high precision pipeline, the second perspective divide circuit performing perspective correction on texture attributes of primitives classified as large or misbehaved.

22. The graphics engine of claim 19, wherein the rendering/rasterization engine comprising:

a pixel iterator circuit connected to the first iterator setup calculation circuit and the second iterator

setup calculation circuit, the pixel iterator circuit performing scan line rasterization on all primitives regardless of classification; and

a perspective divide circuit connected to the pixel iterator circuit, the first perspective divide circuit performing perspective correction on texture attributes of all primitives.

23. The graphic engine of claim 17, wherein the primitive setup engine further comprising a configurable iterator setup calculation circuit coupled to the primitive classification circuit, the configurable iterator setup calculation circuit is configured by the primitive classification circuit to compute the setup equations for a primitive classified as small and well-behaved in a low precision processing mode, the configurable iterator setup calculation circuit is configured by the primitive classification circuit to compute the setup equations for a primitive classified as large and misbehaved in a high precision processing mode.

24. The graphics engine of claim 23, the primitive classification circuit configuring the configurable iterator setup calculation circuit to operate in the low precision processing mode by disabling a plurality of the mantissa bits available for floating-point calculation and configuring the configurable iterator setup calculation circuit to operate in the high precision processing mode by enabling the same plurality of mantissa bits.

25. The graphics engine of claim 24, wherein the rendering/rasterization engine comprising:

a pixel iterator circuit connected to the iterator setup calculation circuit, the pixel iterator circuit performing scan line rasterization on all primitives regardless of classification; and

a perspective divide circuit connected to the pixel iterator circuit, the first perspective divide circuit performing perspective correction on texture attributes of all primitives.

26. The graphics engine of claim 25 further comprising a user interface coupled to the primitive classification circuit, the user interface communicating input information by a user to the primitive classification circuit to configure the primitive classification circuit to operate in a desired precision operating mode.

27. The graphics engine of claim 26, wherein the desired precision mode selected by the user overrides the precision mode selected by the primitive classification circuit.

28. The graphics engine of claim 25 further comprising a power monitor coupled to the primitive classification circuit, the power monitor determining a power level needed to ensure continuing operation of a portable hand-held device until a conclusion of an actively running application and selecting an appropriate precision operating mode, the power monitor communicating the determined precision operating mode to the primitive classification circuit to configure the primitive classification circuit to operate in the selected precision operating mode.

29. The graphics engine of claim 28, wherein the power monitor makes the determination by comparing an indicator of available power with an indicator of remaining operating time of the actively running application.

30. The graphics engine of claim 31, wherein the selected precision mode overrides the precision mode selected by the primitive classification circuit.

31. The graphics engine of claim 22 further comprising a user interface coupled to the primitive classification circuit, the user interface communicating input information by a user to the primitive classification circuit to configure the primitive classification circuit to operate in a desired precision operating mode.

32. The graphics engine of claim 31, wherein the desired precision mode selected by the user overrides the precision mode selected by the primitive classification circuit.

33. The graphics engine of claim 22 further comprising a power monitor coupled to the primitive classification circuit, the power monitor determining a power level needed to ensure continuing operation of a portable hand-held device until a conclusion of an actively running application and selecting an appropriate precision operating mode, the power monitor communicating the determined precision operating mode to the primitive classification circuit to configure the primitive classification circuit to operate in the selected precision operating mode.

34. The graphics engine of claim 33, wherein the power monitor makes the determination by comparing an indicator of available power with an indicator of remaining operating time of the actively running application.

35. The graphics engine of claim 33, wherein the selected precision operating mode overrides the precision mode selected by the primitive classification circuit.

36. A handheld computing device adapted to process three-dimensional (3D) graphics comprising:

a central processing unit (CPU);

system memory coupled to the CPU;

a video display coupled to the CPU;

a graphics/display controller coupled to the CPU, the video display, and the system memory, the graphics controller comprising:

a graphics engine, the graphics engine comprising:

a primitive setup engine receiving data related to graphics primitives from memory, the primitive setup engine comprising a primitive classification circuit, the primitive classification circuit classifying a primitive, based on a classification, the primitive setup engine selecting a processing mode to compute setup equations for the primitive to minimize power consumption without sacrificing quality and performance; and

a rendering/rasterization engine coupled to the triangle setup engine, the rendering/rasterization engine performing primitive pixel rasterization.

37. The hand-held computing device of claim 36, wherein the primitive is classified based on its size and other characteristics.

38. The hand-held computing device of claim 37, wherein the primitive is classified as either small and well-behaved, large, or misbehaved.

39. The hand-held computing device of claim 37, wherein classification criteria for the other characteristics include texture, width, and depth.

40. The hand-held computing device of claim 38, wherein the primitive setup engine further comprising:

a first iterator setup calculation circuit coupled to the primitive classification circuit, the first iterator setup calculation circuit computing the setup equations for a primitive classified as small and well-behaved in a low precision processing mode as directed by the primitive classification circuit; and

a second pixel iterator setup calculation circuit coupled to the primitive classification circuit, the second iterator setup calculation circuit computing the setup equations for a primitive classified as large or misbehaved in a high precision processing mode as directed by the primitive classification circuit.

41. The hand-held computing device of claim 40, wherein the low precision processing mode involves 16 mantissa bits for floating-point calculation and the high precision processing mode involves 24 mantissa bits for floating-point calculation.

42. The hand-held computing device of claim 40, wherein the rendering/rasterization engine comprising:

a first pixel iterator circuit performing scan line rasterization on primitives classified as small and well-behaved;

a first perspective divide circuit connected to the first pixel iterator circuit which is connected to the first iterator setup calculation circuit thereby forming a low precision pipeline, the first perspective divide circuit performing perspective correction on texture attributes of primitives classified as small and well-behaved;

a second pixel iterator circuit performing scan line rasterization on primitives classified as large or misbehaved; and

a second perspective divide circuit connected to the second iterator circuit which is connected to the second iterator setup calculation circuit thereby forming a high

precision pipeline, the second perspective divide circuit performing perspective correction on texture attributes of primitives classified as large or misbehaved.

43. The hand-held computing device of claim 40, wherein the rendering/rasterization engine comprising:

a pixel iterator circuit connected to the first iterator setup calculation circuit and the second iterator setup calculation circuit, the pixel iterator circuit performing scan line rasterization on all primitives regardless of classification; and

a perspective divide circuit connected to the pixel iterator circuit, the first perspective divide circuit performing perspective correction on texture attributes of all primitives.

44. The hand-held computing device of claim 38, wherein the primitive setup engine further comprising a configurable iterator setup calculation circuit coupled to the primitive classification circuit, the configurable iterator setup calculation circuit is configured by the primitive classification circuit to compute the setup equations for a primitive classified as small and well-behaved in a low precision processing mode, the configurable iterator setup calculation circuit is configured by the primitive classification circuit to compute the setup equations for a primitive classified as large and misbehaved in a high precision processing mode.

45. The hand-held computing device of claim 44, the primitive classification circuit configuring the configurable iterator setup calculation circuit to operate in the low precision processing mode by disabling a plurality of the mantissa bits available for floating-point calculation and configuring the configurable iterator setup calculation circuit to operate in the high precision

processing mode by enabling the same plurality of mantissa bits.

46. The hand-held computing device of claim 45, wherein the rendering/rasterization engine comprising:

a pixel iterator circuit connected to the iterator setup calculation circuit, the pixel iterator circuit performing scan line rasterization on all primitives regardless of classification; and

a perspective divide circuit connected to the pixel iterator circuit, the first perspective divide circuit performing perspective correction on texture attributes of all primitives.

47. The hand-held computing device of claim 46 further comprising a user interface coupled to the primitive classification circuit, the user interface communicating input information by a user to the primitive classification circuit to configure the primitive classification circuit to operate in a desired precision operating mode.

48. The hand-held computing device of claim 47, wherein the desired precision mode selected by the user overrides the precision mode selected by the primitive classification circuit.

49. The hand-held computing device of claim 45 further comprising a power monitor coupled to the primitive classification circuit, the power monitor determining a power level needed to ensure continuing operation of a portable hand-held device until a conclusion of an actively running application and selecting an appropriate precision operating mode, the power monitor communicating the determined precision operating mode to the primitive classification circuit to configure the primitive

classification circuit to operate in the selected precision operating mode.

50. The hand-held computing device of claim 49, wherein the power monitor makes the determination by comparing an indicator of available power with an indicator of remaining operating time of the actively running application.

51. The hand-held computing device of claim 50, wherein the selected precision mode overrides the precision mode selected by the primitive classification circuit.

52. The hand-held computing device of claim 41 further comprising a user interface coupled to the primitive classification circuit, the user interface communicating input information by a user to the primitive classification circuit to configure the primitive classification circuit to operate in a desired precision operating mode.

53. The hand-held computing device of claim 52, wherein the desired precision mode selected by the user overrides the precision mode selected by the primitive classification circuit.

54. The hand-held computing device of claim 40 further comprising a power monitor coupled to the primitive classification circuit, the power monitor determining a power level needed to ensure continuing operation of a portable hand-held device until a conclusion of an actively running application and selecting an appropriate precision operating mode, the power monitor communicating the determined precision operating mode to the primitive classification circuit to configure the primitive classification circuit to operate in the selected precision operating mode.

55. The hand-held computing device of claim 54, wherein the power monitor makes the determination by comparing an indicator of available power with an indicator of remaining operating time of the actively running application.

56. The hand-held computing device of claim 55, wherein the selected precision opeating mode overrides the precision mode selected by the primitive classification circuit.

57. A method for processing data comprising:

classifying a data set based on at least a criterion; and

based on the classification, selecting a processing mode to process the data set to minimize power consumption without sacrificing quality and performance.

58. A method for processing 3D graphics comprising:

classifying a primitive based on its size and other characteristics; and

based on the classification, selecting a processing mode to compute setup equations for the primitive to minimize power consumption without sacrificing quality and performance.

59. The method of claim 58, wherein the primitive is classified as either small and well-behaved, large, or misbehaved.

60. The method of claim 58, wherein classification criteria for the other characteristics include texture, width, and depth.

61. The method of claim 60, wherein a low precision processing mode is used for primitive classified as small and well-behaved and a high precision processing mode is used for primitive classified as large or misbehaved.

62. The method of claim 61, further comprising:
receiving input information from a user; and
selecting a desired precision operating mode based on the input information.

63. The method of claim 62, wherein the desired precision mode selected by the user overrides the precision mode selected by the primitive classification step.

64. The method of claim 61 further comprising;
determining a power level needed to ensure continuing operation of a portable hand-held device until a conclusion of an actively running application; and
selecting an appropriate precision operating mode based on the power level determined.

65. The method of claim 64, wherein the determination is carried out by comparing an indicator of available power with an indicator of remaining operating time of the actively running application.

66. The method of claim 65, wherein the selected precision mode overrides the precision mode selected by the primitive classification step.